EDITORIAL

ARRIVE: new guidelines for reporting animal research

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In 1980, Altman wrote that misuse of statistics in medical research was unethical (Altman, 1980). This article was the first of many, written to improve the standard of statistical analysis and reporting in medical journals, and the endeavour has been largely successful. Other factors have also been at play over these three decades. The regulation of ethical standards and approval increased, more control of data collection was required for the licensing of drugs, and 'evidence based' practice became popular. This approach to the analysis of information uses a structured process and allows later assembly of data from separate studies, impossible without full details. To allow these details to be reported in a consistent way, and accessible for further use, the CONSORT statement defined guidelines for reporting trials (Begg *et al.* 1996). The International Committee of Medical Journal Editors introduced guidelines for reporting, and in 2005 required that all clinical trials should be registered in a publicly accessible database. On occasion, these requirements may still not be properly met. For example, although studies may be registered, the end point for analysis may not be specified, leading to subsequent uncertainty and sometimes controversy (Leo, 2009).

The practice of reporting of animal research has not advanced at the same rate. In a recent survey of our journals we found that omissions of relevant and important statistical details were common. Animal research in the UK has been legally regulated for many years, with a specific and exacting system of ethical review, and practical oversight of animal studies. However, after a parliamentary review, an independent but predominantly government-funded body was set up in 2004: the National Centre for the Replacement, Refinement and Reduction of Animals in Research (NC3Rs). An important aim for this body has been to connect with the public, and government surveys now assess public attitudes to these topics. This body is also concerned with improving the quality of study design and reporting. The NC3Rs recently surveyed the standards of reporting on animal research (rats, mice and non-human primates) in studies carried out between 1999 and 2005. Out of about 170,000 relevant publications, a carefully selected sample of 271 studies was analysed for quality of reporting, and 48 in more detail for quality of study design and analysis. The prominent 'errors' in reporting were not exactly stating the hypothesis to be examined, the means of determining sample size, or the method of randomisation. These results were used to construct a set of exact guidelines on the conduct and reporting of animal studies, based on the previous CONSORT guidelines for human studies. The new guidelines have a new acronym: ARRIVE, which is Animal Research: Reporting *In Vivo* Experiments, and provide explicit and unequivocal instructions on reporting animal experiments.

One of the authors of this editorial recently described *The Journal of Physiology*'s advice to authors as 'mild encouragement', and wrote a firmer guide (Drummond, 2009). Despite the aim to be more exact, this firmer approach has been described as providing 'little or no guidance on what information to report when describing *in vivo* research'. Thus, the new ARRIVE guidelines represent a new degree of stringency in requirements, which we fully endorse as a means of improving scientific reporting and ethical standards in animal research, although the latter aim has long been an aspiration of both *The Journal of Physiology and Experimental Physiology*. These guidelines are supported by other bodies such as the International Council of Medical Journal Editors (2008), the Council of Science Editors (2009), the Committee on Publication Ethics (2010), and the Nuffield Council for Bioethics (2005).

In some fields, we would encourage even more detail. For example, the method of killing (not euthanasia) is often relevant, scientifically and legally, and the means of providing care after procedures, such as analgesia, may also be highly relevant. For animal studies performed under anaesthesia, blood pressure, heart rate and blood gases should be measured and recorded. The criteria for additional doses of anaesthetic should be stated and data on additional administration should be included in the Methods.

Good science is best served if these principles are applied from the start of the study: the plan and design of the experiment should apply sound statistical principles. To that end, *The Journal of Physiology* hopes to publish a series of short editorials, specifically aimed at the non-expert, to aid good design, execution and presentation of experiments.

References

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